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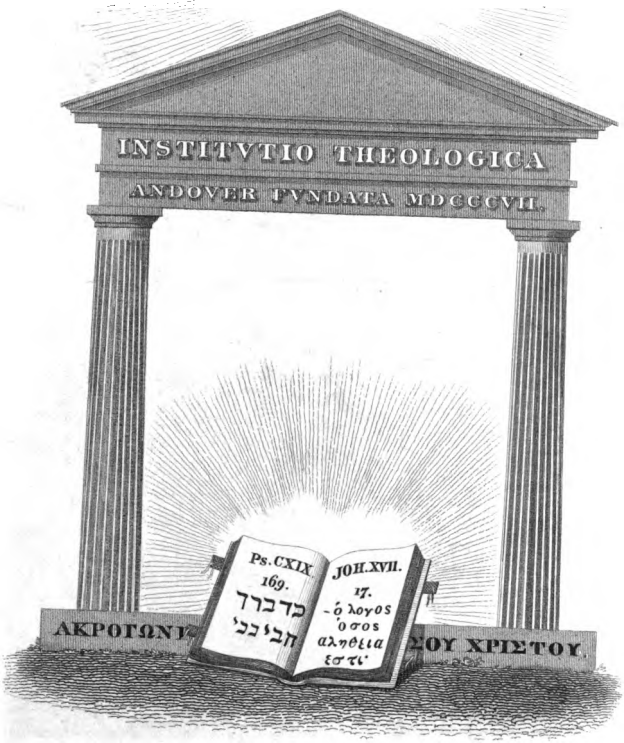

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A DIALOGUE

ON THE RELATION

BETWEEN THE VARIOUS FORMS OF MATTER

WHICH AFFECT THE SENSES.

BY

ALEX. STEPHEN WILSON.

LONDON:

SAMUEL HIGHLEY, 32, FLEET STREET.

1855.

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"All analogy leads us to infer, and new discoveries continually direct our expectation to, the idea, that the most extensive laws to which we have hitherto attained, converge to some few simple and general principles, by which the whole of the material universe is sustained, and from which its infinitely varied phenomena emerge as the necessary consequences."

BABBAGE.

25, 617

T. E. METCALF, PRINTER, 63, SNOW HILL.

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PREFACE.

HAVING endeavoured, without success, to obtain for the question discussed in the following pages the opinions of various scientific gentlemen, I have resolved, instead of intruding myself further in that way, to appeal to the public. I took the liberty of soliciting these opinions, in order that, should my views appear to competent judgment crude and hasty, and destitute of any catholic claim, I might avoid exposing them to public condemnation;—that is, supposing the public kind enough to notice them. But being firmly persuaded in my own mind, upon the most mature view which I have been able to arrive at in a long course of study, that the doctrine here submitted is not only true, but of considerable importance, I venture to put it forward for the verdict of others. Some of its more obvious consequences I have endeavoured to investigate in

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a much larger work. Whether that work shall appear will depend on the reception met with by the present tract. There is but one thought here set forth, and that thought is, that the medium of seeing is elementally correlated to the media or objects of the other senses: in other words, that all forms of matter are derived from the same stock of elements. That is the proposition sought to be proved. It is virtually proposed by Newton in one of the questions at the end of his *Optics;* and that the reader may be the more disposed cautiously to estimate the proof it rests upon, he may be here informed that its chief and most startling consequence, if true, is, that the creation and constant enlargement of our globe and its planetary kindred is *the* very work which is being carried on in the system at this moment. We have to search neither the fabulous past nor the nebulous distant for the method of God's creative agency, but to stand where we are, and interrogate Nature as to what that work is which she is continually plying here. And she may inform us, from the new ground taken, that a

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globe is not created, in our sense of the term,—is not finished and set up in its ultimate position and dimensions when it has become a round ball, and has reached a diameter of eight thousand or eighty thousand miles. If our plain and intelligible optical, or rather physical, proposition be a fact, one of its necessary consequences is nothing less than that the body at the centre of our system is being decomposed, while its effete matter subserves the reverse process in respect of the bodies circulating about it—with a direct reference to that decomposition. Lord Rosse's discoveries, if they have not refuted Laplace's cosmogony, have taken away the foundations on which it was originally built; so that, in strictness, the theory ought now to have no existence; since, had our present knowledge of the objects on which it was founded existed in Sir W. Herschel's time, that theory would never have been grounded on these objects. The cosmogony of Moses leaves the *method* of globe manufacture an open question. We have gone abroad for creation, as if nothing so grand could be transpiring at home; but since we are

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in want of a cosmogony just now, there will be no harm, before launching out into space again, of inquiring a little more particularly what that work really is which is going on here. The present attempt is not so much an attempt to settle the question treated of, as to open up what, I confess, appears to me a new and extensive field of investigation; and I trust it may merit a candid consideration, even should it be denied any higher character than that of hypothesis. I will not conceal, however, that it assumes to be founded upon experiment and observation; and that, if the inference be false, it is not false because a hypothesis, but because it is an illogical induction.

A. S. W.

BONNYTON BY OLDRAIN,
Nov. 20, 1854.

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THE UNITY OF MATTER.

Sylvius. We have agreed, I think, that as regards the material universe, the causes of phenomena are not to be sought by us in our present state of existence, beyond the material world itself;—what then, I would ask you, Mentor, is the object of natural science?

Mentor. By persons pursuing science for different purposes of practice or speculation, different ends will be proposed. But, in my opinion, the final object which the man of science—regarded as a philosopher—consciously or unconsciously follows after, is such a view of the material economy as shall give entire satisfaction to the mind.

Gravius. But what proof should we have that a view which afforded a mental satisfaction, should be truly representative of the reality of things?

Ment. Although the constant aim of natural science is to arrive at a view of the material world, in which our mental picture should be an exact counterpart, or echo of that world, yet we can only appeal to our senses in confirmation of the knowledge we have already acquired by these senses; but

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notwithstanding this, since the view we allude to is based upon sensation, we cannot but believe that when it is complete it will harmonise throughout, and yield that satisfaction which to arrive at hath been the constant toil of philosophers since they entered upon the solution of those phenomena which on all sides present themselves.

Gra. But do you not think that this mental satisfaction is a somewhat indefinite aim? Would it not be more to the purpose of discovery to set about the investigation of those principles, or laws, by which material forms arrange themselves?

Ment. That is necessarily the course which must be taken, in order to arrive at what I have stated as being the resting place or goal of speculation. At various periods in the progress of science, the mind has rested satisfied with views which we perceive to be conflicting. These views, however, satisfied, in a great measure, that state of mental developement in which they had their origin, and nothing further was then desiderated. And now, the mind will not feel that it has solved the great cosmical riddle, until it has perceived the relationships of the various forms of matter, and the various bodies of space. Our view of Nature must be simply a photograph. We are not to mix up that view with powers inhering in matter, whose competency and mode of existence we do not understand. Our causes must be material antecedents. Where a body is perceived

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in motion, and moving in a certain relation to other bodies, as with the bodies of our solar system, we must ascertain in what relation this motion stands to some other motion required to produce it; and in what relation that other motion stands to a previous one, and so on, not *ad infinitum*, but round to the point from which we originally started. Phenomena must not be left in a state of anarchy. The picture of Nature must be one. Every individual object must be seen to be related to the whole. For example, the motion of a planet is no longer to be viewed as if it were a phenomenon standing by itself. If we regard such a motion as being communicated to the body by forces not necessarily evolved within the system, the unity of the picture is utterly destroyed. And surely it is more in accordance with just logic to think with Plato, that God must have made the system complete in itself, than that extrinsic forces should be requisite to supply what, in sucha case, must be regarded as defects. If an animal can be made to evolve from a germ, and possessing within its mechanism its own motive powers, there is nothing to hinder a solar system to grow up, standing in a like relation to the Creator.

Gra. You mean to say, then, that we are not to accept of any motions as having been originally impressed upon the bodies of space? In what manner do you propose to account for the tangential motion of the planets, and for the motion of that which

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moves them, and so on, until you arrive at the planets themselves as causes of motion?

Ment. We are by no means ready as yet to make so great an advance. Yet the simple principle I shall by-and-bye lay before you, contains the solution of what you propose. But you will understand what I mean regarding the interdependence of cause and effect throughout the whole of Nature, by considering the economy of the waters of our own globe. Take them at any point, and you find that there they form a link of a circle which returns into itself—the chain is not interminate. From the ocean the solar action disengages vapour; that vapour is condensed, and falls in the form of rain: it is collected in streams, and again discharged into the ocean, completing a circle, which we may find to be but a type or repetition of a higher circle, in which the whole material scheme is embraced. Regarding this epicycle of motions, the mind is in so far completely satisfied: it perceives the relations between the water in one position and one form, and the same matter in previous and subsequent stages. No fiatory forces require to be introduced to fill up the gaps in our real knowledge. In so far the picture is complete. The circle ends in itself, and gives the idea of a unity—a thing in which all the parts are perceived to make one whole.

Syl. But we can never imagine that the wider economy of Nature is of this character, when we find

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such a form of matter, for example, as a universal ether, which has no chemical or elemental relation to ordinary forms of matter. This rather gives to Nature the character of a duality than of a unity; for this ether refuses to form any portion of your universal circle of sequences: and indeed we have no right to assume *à priori* that the material world is a unity of the kind you insisted upon in our conversation yesterday.

Ment. But does not Gravius account for the phenomena, in whose favour you bespeak the assistance of a universal ether, by the hypothesis of emanations from what he calls luminous bodies?

Gra. The hypothesis you mention is equally fatal to your doctrine of unity. It may be very true, as you asserted yesterday, that the matter of the fifty or sixty elements of the chemists may form a unity, in which no particle can be lost, but where every particle, on being released from one form or combination, immediately enters into some other; but the particles emitted from luminous bodies, seem certainly to be thrown into space, and taken no further advantage of. Where, then, is that peculiar unity for which you contend?

Ment. To me, I confess, the improbability seems great, that there should be any such matter as that of which these emissions are said to consist. Nor is the opinion a whit less improbable, which regards the whole universe as blocked up with a stagnant

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ether. We have not yet, as I conceive, exhausted the capabilities of that ordinary matter, of whose existence we are certain. I propose, therefore, that at present we consider the nature of matter. We need not, I think, enter into any metaphysical discussion on this subject, but simply regard the term matter as equivalent to sensible object; for although there are forms of which we are not directly sensible, yet the inference by which we arrive at them is a step so short, that no material error can result from regarding matter as synonymous with *that which can produce sensation.* Some have no doubt regarded the term as standing for a substratum of sensible qualities; but since we have no faculties by which we can penetrate beyond sensible qualities, it seems clear that at bottom the term matter could never have really been anything more than a general name, combining in one all our sensations, in the same manner as the general name animal comprehends all living creatures, but is itself a mere creature of the mind. Had colour, for instance, been the sole sensation derived from without, then colour and matter had been convertible terms. But I will show this more clearly by a table, whenwe have concluded our conversation.

Syl. But may there not be different kinds of matter? For example, if the intimate nature of hydrogen be different from that of oxygen, may there not be, as is very generally held by physicists

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of the present day, an ethereal kind of matter, different from any form of matter with which we are acquainted on this globe, and different from any form which ordinary matter may assume?

Ment. That is a question much more dependent for its solution upon just logic than may at first sight appear; for what is our idea of matter derived from? Plainly from such sensible objects as our experience has had to deal with. And I must protest against the assumption that by accumulating experiments, we may arrive at a true interpretation of Nature, without attending to the just grounds of reasoning.

Syl. But may there not be a sort of matter of which we have had no experience?

Ment. Possibly it might be as correct to speak of men existing, entirely different from the men of which we have an idea, as to speak of matter different from that of which we have had experience. In the one case we should be speaking of "men" different from men, and in the other case of "matter" different from matter. We cannot emancipate ourselves from the sources of our knowledge; and if we are to speak with a positive and literal meaning, our words must be applied to things similar to the things which gave occasion to the use of these words. And even in the very act of making the hypothesis of a specific ether, we do at bottom proceed—for the limits of our faculties will not be overstepped—upon

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the ground that there is no repugnance between our idea of a medium of vision and the constitution of ordinary matter, since it must be through our experience of the various forms of ordinary matter that we are able to form the conception of an ether at all; so that in such a hypothesis as you advocate, we have not really got beyond ordinary matter. But not to press the subject from this point of view, what proof can you adduce of the existence of a universal ether?

Syl. I am willing enough to admit that, in the first instance, the supposition of the existence of this ether was hypothetical; but now so many optical phenomena have been explained upon the hypothesis of an ether, that little doubt seems left of its real existence.

Ment. But you must admit that this original supposition was made upon grounds which sound logic cannot countenance. By this supposition, *matter* was created of a species unknown to experience, and beyond the reach of experience, and for a purpose which experience did not know whether it was able to subserve.

Gra. But I think, Mentor, those who hold this hypothesis do not regard the ether as material at all. At any rate, the emissary theory which I hold, is by them sometimes designated the material theory.

Ment. But if this ether be not matter, what is it?

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Syl. It may not be matter in the ordinary acceptation of the term, and yet be an agency capable of acting on bodies.

Ment. To me I confess this is wholly unintelligible. To speak of an ether which is not some form of matter, nor yet spirit, is, I suspect, to speak of nothing at all.

Gra. That is my opinion; and I cannot but regard the undulatory theory as more material than the theory of emission. The latter requires matter only where optical phenomena are exhibited, whereas the former is based upon a universal ocean of matter, for matter it must be.

Ment. Both hypotheses, at least in their foundation, I regard as equally untenable; and cannot but think that ordinary matter will be found capable of doing whatever any kind of matter is brought forward to execute. But tell me, Sylvius, the nature of the proofs for the existence of your subtile ether.

Syl. Perhaps the best proof, apart from optics, is that derived from the contraction of the orbits of comets, especially the comet of Encke. At each successive revolution of this attenuated body, the period is found to have diminished by a greater quantity than can be assigned to the perturbative powers of the planets. And hence the inference, very generally acquiesced in, that the body is retarded, its orbit diminished in breadth, and its period also diminished in consequence. And the most

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obvious, and, in fact, the only conclusion from these is, that this retardation is due to the resistance of an ethereal medium.

Ment. I do not exactly see that an ethereal medium is a good solution of this difficulty. It is well known that great changes take place in the constitution of comets on their approach to, and recession from, the sun. And since the cause of these changes has not yet been arrived at, we do not know but that these changes may result in a change of the periodic time. One comet, called Biela's, has been seen to separate into two; Encke's comet undergoes a contraction and enlargement each revolution; and if the changes universally observed to take place upon comets are rendered permanent, or are part of a progress through which these bodies are passing, it can hardly be expected, even in absence of an ethereal medium, that the forces acting on these comets should produce one unchanging result, while the body acted upon is constantly changing. And although you may regard this as displaying great ignorance of what are said to be the necessary results of the first law of motion, yet I cannot regard that law as a physical cause of motion, or of the continuance of motion, but only an expression of an observed result. I know it is customary to say the cosmical bodies necessarily persist in motion when once this motion has been originated; and this I am willing to admit.

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But the practical question is, what is the physical cause of tangential motion in the planets? And are we not justified by all analogy in regarding the force of projection, as a presently acting force, as well as the centripetal force? But the claims which geometry makes in favour of the first law of motion would lead one to suppose that this first law was one of the objective agents of Nature, and not a mere descriptive maxim. Surely the varieties of planets and comets, and the great differences in their motion, and in the forms of their orbits, might have led science to the conviction, that an original fiatory projection is an insufficient solvent, and that the structure of the given planet or comet itself, has something to do in determining its position and the form of its orbit. And if one of the general laws of the system is to retain its integrity, the diminution of this comet's orbit, must lead not only to a diminution of period, but likewise to an acceleration of the comet's motion, for the lower bodies of the system, or those nearer the sun, move more rapidly than the higher; and although it may be admitted that a resisting medium, and a centripetal attraction, would diminish a comet's orbit and its period, it can by no means be admitted that these causes alone could communicate acceleration of motion. Were Jupiter suddenly translated to the orbit of Mars, although he would perform his revolution in shorter time, he

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would not, under the agencies presently recognised, move any faster than in his previous position. But the probability is, that existing agencies would not permit Jupiter to occupy any position but that which he holds; and that were it possible for this planet to revolve in a more contracted orbit, he would be impelled by present forces to assume a more rapid motion, and to occupy that relation to the other planets, which is expressed in Kepler's third law. But this introduces elements into the problem other than primary projection and centripetal attraction; elements which recognise the importance of the physical constitution of the bodies of the system in an astronomical point of view, and which are not contemplated by Encke and those who have followed him in attributing the diminution of this comet's period to a retarding ether; and how these elements affect the problem, and change the whole aspect of physical astronomy, we have not time at present to consider. But what proofs can you bring from optics for the existence of an ethereal medium?

Syl. The phenomena of interference, and many others which are found wholly inexplicable upon the theory of emission, are justly regarded by philosophers as affording strong proofs of the reality of such an ether as I contend for; and the analogies of hearing, and the waves of liquids, also strengthen this hypothesis,—as exhibiting a mode

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of the transmission of motion without transmission of matter, which entirely oversteps the extravagant notion of the projection of material particles from bodies so distant as the sun and stars; for it seems inconceivable that any force should exist capable of projecting particles with the rapidity at which luminous impressions traverse space; and although some have contended that no medium is requisite to vision, nor to the maintenance of planetary relations, this seems a supposition which cannot be entertained until we be able to conceive of the transmission or the prevention of motion where no body is moved. Some medium is undoubtedly requisite to vision; and it seems a matter of small importance what the intimate nature of that medium is.

Ment. To me, what you call the intimate nature of the medium, seems of the very utmost importance. Till this be decided, we cannot be said to know in what physical relation the sun stands towards his rising family of planets. And, doubtless, the unfolding of many physical mysteries, waits the decision of the question relative to the elemental relation in which the visual medium stands to other forms of matter. I am not so much concerned to know the mode of motion in the visual medium, as to know the elemental or chemical relation in which this medium stands to ordinary matter. Now it has been remarked by a very profound logician, that

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the superstructure of the undulatory hypothesis, the ether and its modes of motion, are mere creatures of the hypothesis, framed purposely to meet the requirements of certain phenomena, and that therefore these phenomena can be no proof of the existence and peculiar motions of a specific ether. Nor can any motions whatever, prove that the visual medium is a specific fluid, having no elemental relation to common matter. But as you observed that it seemed of little importance what the nature of the visual medium was, so your hypothesis may remain intact, even if it can be shown that this medium is nothing more than simply one of the forms which common matter may assume.

Gra. I think we are all agreed that between luminous bodies and the eye, some medium of vision is absolutely required. And it appears to me, from what Mentor has said, that we do not possess mental instruments whereby we can transcend the field of our experience, and propose the hypothesis of an ether having no elemental relation to ordinary matter.

Ment. And what better is your own hypothesis of luminiferous particles? But in the meantime, let me ask you, Sylvius, since we are agreed, as Gravius says, regarding the requisiteness of a medium in vision, what, in any case, is the cause of motion in your specific medium?

Syl. For my own part, I have never thought it

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necessary to ascend so near the fountain-head of the hypothesis.

Ment. But without ascertaining the source of motion, or the antecedent motion, effecting the medium, it is clear your hypothesis is radically defective, and takes no hold of the other departments of Nature. Motion in one body can only be originated by motion in some other body, or in something equivalent to it; and while such a hypothesis or half-hypothesis exists in science, science can never come into contact with the real unity of matter. So long as one portion of science remains isolated from others, science can never be truly representative of Nature, if Nature be, as we have many reasons for believing that it is—one great scheme.

Syl. So far as I know, no philosopher has attempted to show the mode in which motion is produced in the ether. But this is surely no good reason why its motion should be denied. If a savage be shot through by a musket-ball, his companions may believe that there was motion in the ball, although the cause of that motion may be to them as yet unknown.

Ment. But the case is different when the very character of the motion is laid down by the hypothesis. I should admit the vibratory motion, without inquiring into its cause, if the hundreds of billions of vibrations in a second were objects of observation. But we want to know, how ordinary

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matter, in any of its many forms, is capable of impressing this extraordinary motion upon the medium of vision.

Syl. Is it not probable, then, that the agitation which we know to be consequent on various chemical combinations, especially such as are of a violent nature, might communicate itself to a surrounding ether?

Ment. No doubt such agitation must communicate itself to a surrounding ether, if any such exist. But this agitation can only be a mechanical motion of matter, and then the question arises, why do not all violent motions of bodies produce light? But let us not anticipate Nature. Let us commence our experiment in the dark. Here we have nothing to suggest the existence of an extraordinary ether. And let us suppose that we possess our present knowledge of material transmutations, but have never had the sensation of vision. Suppose now, that we bring together such a combination of bodies as shall give rise to combustion. When the light first bursts upon us, what ought we to infer? Ought we to infer that there is an ethereal medium pervading space, and that certain motions of the bodies we have mingled together have put this ether into a vibration? Or should we infer that the medium, by which our vision is affected, is a direct product of the bodies we have brought into union? We are certain that combination gives birth to new forms;

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and here is a new form directly springing out of the others. We do not know that combustuous combinations can give motion to ethers; but we know that they must give rise to new compounds, and that if these be of a fluid character, they must disperse themselves, owing to the greater volume they occupy. So that, by this simple principle of explanation (too simple, indeed, for many people), we have a visual medium produced in a manner analagous to that in which all other forms are produced; and its cause of motion reduced to that law which expresses the tendency to equidiffusion of all tenuous fluids. But how do you account for solar-light?

Syl. Sir John Herschel imagines it possible in the case of the solar light, that this light may be produced by currents of electrical matter constantly circulating in the sun's immediate neighbourhood.

Ment. But what moves the electrical currents? And how is it shown that these currents are capable of putting the ethereal medium into a state of undulation? Nor, in reviewing such questions, can we avoid being perplexed with others? What is it that is going on in this universe? What is all this stir about? Mere motion, eternally perpetuated, and barren of any progress, it cannot be. And to imagine that this grand phenomenon of light is but the humble menial of animal vision, is to elevate ourselves into a very undue importance. In forming our senses, the Creator seems

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merely to have taken advantage of the forms of matter already necessary to the cosmical economy. And, undoubtedly, there is some great fact underlying the relation between the visual form of matter and other forms. But you say that the motion of the ethereal fluid is undulating without any propagation of the medium; now tell me the manner in which such motion can be produced.

Syl. The waves upon a pool, and the undulation of the air produced by a sonorous body, are examples of this undulation. True, these are not quite identical with the vibrations of the ether; but they show in a popular way the possibility of such vibrations in fluid masses.

Ment. But rightly considered, the sound motions of air are not undulations at all. They are propagations of the air for a certain distance, with a relapse or propagation in the contrary direction. And it is only in so far as the motion is propagation, that any aural effects are produced. And besides, in this case the undulation, if it be called such, is in the line of what may be termed the aural ray; whereas, the vibrations of the luminous ether are said to be perpendicular to the line of the ray, which seems to introduce a mathematical impossibility, since such rays, diverging in all directions from a radiant point, must neutralize each other's vibrations, and produce simple propagation. For, if the impact of one portion of the ether on another be

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capable of giving motion to that other, contrary motions of portions of the ether are capable of neutralizing each other; so that transverse undulation in all directions, from a radiant point, is physically impossible. On the other hand, it is an error to suppose that when a stone is thrown into a pool, waves merely are produced, without any propagation of the water. It is because of the sudden propagation from the point where the stone displaces the water that the waves are produced. A large enough stone would propagate the water out of the pool altogether; and in this case, it is only because portions of the water can be elevated above the average level of the surface that waves can be produced. Were the stone suddenly created a mile below the surface of the sea, there would simply be a propagation of the water in straight lines from the centre of displacement, without any of that forward and backward motion called vibration. And the case seems to be precisely similar to this, on the introduction of a luminous body into an ocean of ether. The ether may retire in straight lines, but that it can vibrate perpendicularly to radii drawn in all directions from a luminous point, seems to me a physical contradiction.

Syl. But is it not admissable then, that a short propagation of the medium, and a subsequent relapse, may be adequate to all the phenomena of optics?

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Gra. But if there be propagation for however short a distance, this hypothesis and that of emission, are so far practically the same.

Ment. It seems indeed, to me, that without propagation in the line of the ray, no effect whatever can be produced by a ray. Were the air, in aural impressions, not propagated so as to impinge with some force on the organ of hearing, no such result as hearing could be produced. And as regards the organ of vision, the case seems to be the same. The medium of vision must, at least for a certain distance, be propagated from the object rendered visible. Whether the medium be propagated the whole distance, or only the impression be propagated through the medium, as in hearing, we shall have to consider. But is not the mechanism exceedingly complicated and hypothetical, by which the red rays receive four hundred and fifty-eight billions of different vibrations in a second, and the intermediate rays intermediate numbers, until, at the extreme violet, the vibrations in a second amount to seven hundred and twenty-seven billions? How can any form of ordinary matter be the cause of such motions as these?

Syl. But what right have we to expect the structure of Nature to be more simple than we find it? And if the machinery of these undulations seem cumbrous, yet it is by no means so extravagant as the notion of a repulsive force, for ever casting out

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particles into space never more to be used in the economy of Nature.

Gra. It is by no means certain that these particles are never again used. In an article in an early number of the "Edinburgh Review," the notion, propounded by Le Sage, that the particles ejected from the sun in course of time again return to the sun, in some other form, is considered as highly probable, and as suggesting a view of the subject, very conformable to many analogies presented on our globe, as that, for instance, of the oceanic waters.

Ment. But I beg you will observe, that if the undulatory theory should be found false, that does not prove the corpuscular theory true. The controversy is not between you, but between any one of your theories and Nature. And there is one consideration, Sylvius, which I would press upon your attention, and that is,—since the forms and motions of ordinary matter are capable of generating that motion in the ethereal medium which subserves vision, why may not these forms and motions of ordinary matter produce vision in their own right?

Syl. But then we should still want a medium between the ordinary matter and the visual organs.

Ment. But why may not the ordinary matter itself, reduced to what may be called its opticable form, be this medium? For the motions of ordinary matter must first show what is to be done.

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Syl. We cannot surely entertain a notion so repugnant to observation, as that of the matter of the sun and stars being dissipated; and yet your doctrine ends in this.

Ment. Why may we not admit the decomposition of the sun and stars? Even within the period of human history stars have disappeared from the heavens. We never find light produced without the decomposition of some body; and I can see nothing more extravagant in the notion of the decomposition of astral bodies—if such decomposition gives rise to the composition of other similar bodies—than in the decomposition and dissipation of bodies on our globe, which necessarily results in the production of others. When I see a fire at a great distance on this globe, I instantly infer that the matter, giving out the light, must be decomposing more or less rapidly; and why, when I see a star behind that fire, should mere distance make me adopt a new principle of interpretation in respect of its light? Newton held one principle to be applicable to both. And whether the principle be "true" or not in respect to astral light, it cannot be denied to be "sufficient." And it is clear that no motions of ordinary matter can generate motions different from themselves; so that you must admit, that the form of ordinary matter which in any instance moves the ether, is itself moving in a similar manner; and if this be so, why should Nature em-

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ploy another agent than ordinary matter, to do what ordinary matter must thus be granted capable of doing?

Gra. Is not that the doctrine propounded by Grove in his "Correlation of Physical Forces?" His assumption he says, is, that "wherever light, heat, &c., exist, ordinary matter exists, though it may be so attenuated that we cannot recognise it by the tests of other forces, such as gravitation." "On the other hand," he proceeds, "a specific matter without weight must be assumed, of the existence of which there is no evidence, but in the phenomena for the explanation of which its existence is supposed." And he concludes by observing, "that the assumption of the universality of ordinary matter is the least gratuitous."

Ment. My conception of matter is not quite similar to that of Grove. For although this very clear thinker insists that ordinary matter is present wherever such results as vision and heat are experienced, he does not seem to desiderate a peculiar form of ordinary matter as necessary to purposes of vision, but imagines that luminous impressions may be propagated through the particles of air, water, glass, and such like, in the manner of vibrations. Whereas, it appears to me a better interpretation of phenomena, to regard the medium of vision as one of the cardinal forms of ordinary matter, propagated from any point where ordinary matter

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is being converted into this form, out of other forms.

Syl. I must confess, that this view does seem more agreeable to the character of Nature, and to the analogy of other transmutations, than the supposition of a specific ether filling all space, and in various degress of density, the pores of bodies. But I do not see that it militates much against the undulatory hypothesis, for space and the pores of bodies will still be in great measure pervaded by this medium, and a form of ordinary matter may undulate as well as an ether.

Ment. That is exactly what I mean. We cannot at present enter into the details of the undulatory hypothesis; but if it shall be found true, that the medium of vision undulates, that will be a fact, as I said already, having no relation to the elemental character of the medium. If it be found that vibration is a fact of the mode of motion in the medium of seeing, that will not break the tie of consanguinity between it and the forms of matter patent to the other senses. But it seems probable, not to say certain, that a ray of light which may have previously moved in a direct line, and the matter of which has been propagated through space, shall on entering such a medium as glass, excite in that glass a vibration which shall re-act upon the ray, and put it into a similar vibration, the ray then combining in its mode of motion both propagation

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and vibration, but being in its essence neither an ether, nor specific emitted particles, but simply one of the reciprocal forms of the common material unity.

Gra. It appears to me that the doctrine you are going on to enunciate, is no other than that proposed by Sir Isaac Newton, when in his 30th query, at the end of his "Optics," he asks:—"Are not gross bodies and light convertible into one another?" Sir Isaac, at the same place, proceeds to state a great variety of transformations of bodies, observing that, "the changing of bodies into light, and light into bodies, is very conformable to the course of Nature, which seems delighted with transmutation."

Ment. That is precisely the doctrine I want you to consider; for, although the question you bring forward has been often quoted, no one appears to have duly investigated what is really involved in its solution.

Syl. But it has long been before the world, and has not seemed to any one worthy of the least attention.

Ment. That is often the case with great truths. It is thought, from a sentence in Plutarch, that the Copernican system of our planets was known to Pythagoras, and yet the mind of the world did not seem prepared for the reception of this system until the exposition of Copernicus. So far as I am aware, no one since Newton's time has seriously made this a question of science at all: and yet, if we are to be

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guided by observation and experiment, there is not in all science a more obvious inference than that which holds light to be the transformed material of gross bodies. But if this inference be true, it certainly shows very forcibly the value of not neglecting to cultivate just methods of interpretation for the sake of perfecting the art of observation; since, although all men in all ages have had the phenomena of the production of light constantly before their eyes, no one, till the time of Newton, seems to have entertained this interpretation, even as a hypothesis. And if this question was judged worthy of the investigation of posterity by such a man as Newton, it cannot surely be regarded as altogether trivial.

Syl. But you do not mean that this doctrine of the elemental correlationship of light and ordinary matter, suggested by Newton, is a truth, if truth it be, at all comparable to the great fact of the heliocentric theory of our system?

Ment. We have not yet examined into its consequences. In the meantime, it is clear that Sir Isaac himself had laid no proper hold of this thought; for, in a letter to Dr. Bentley, he speaks of matter being divisible into two kinds—luminous and non-luminous; and of the solar system being formed of two sorts of matter, one sort composing a shining body, the other opaque bodies. Now, I hope to make it clear to you, that luminosity is no quality

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of matter at all, but simply an effect of the action of a certain form of matter on our faculty of vision. But as you, Gravius, hold Newton's ordinary theory, tell me in what way luminous particles are ejected from what you call luminous bodies.

Gra. It is by the principle of repulsion.

Ment. But what do you mean by the principle of repulsion? You object to the doctrine that ordinary matter is capable of assuming a form related to the sense of vision, and yet you make no scruple of endowing matter with mysteries a thousand times more inexplicable.

Gra. Repulsion is the opposite or counterpart of attraction, or gravitation—the grand principle which, if it does not bestow, at least conserves, the motion and the structure of the solar and astral systems.

Ment. I will own to you that I have spent a considerable time in looking through the works of Newton, and other scientific inquirers, in order to ascertain the nature of this principle of attraction or repulsion.

Gra. The nature of the principle is not known, nor does any one now think of inquiring into it: we know only its effects. We regard the principle itself as a final ordinance of Nature, no more to be explained than the existence of matter.

Ment. It is not the ignorance of man regarding any principle of Nature of which I complain; it is the using of such a term as attraction—not only

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in ignorance of what Nature means by it—but in ignorance of what we ourselves mean by it. What right has any man, who really looks to the satisfaction of his own private difficulties, to say that the planetary orbits, for example, are guarded from disruption by attraction, while he himself knows not in his own mind what he means by attraction? Very true, we are not to inquire into the nature of attraction, but not because a cause of motion which man does not comprehend, undoubtedly exists in Nature; but because, until the principle named attraction be perceived to be a principle capable of producing motion, we ought to give no attention to it, but simply investigate the available causes of motion and forms of matter subjected to our means of investigation.

Gra. But the existence of the principle is altogether undeniable. The planet Neptune was discovered in virtue of it.

Ment. The planet Neptune, I admit, was discovered in virtue of real laws of Nature. But why we are to be called upon to subscribe to an undeniable principle whose mode of action, and whose very power to act have not been shown, I am at a loss to perceive.

Gra. But you do not deny that the planets are maintained in a certain connection with the sun.

Ment. No, I do not deny that, nor do I deny that real forces are requisite for maintaining this con-

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nection. But why these forces are to be regarded as no objects of human investigation, I do not know. Nor can I see that any real advance is made by calling these forces attraction—implying spontaneous action in matter—when we have not discovered what the nature of the forces are, nor yet have laid down to ourselves a determinate connotation to the word attraction. We have got Nature to study; but if men will propose an inexplicable principle, as Locke calls attraction, and then tell us such a principle is final, and no object of investigation, we can hardly be blamed for asking in what respect they have advanced our knowledge of Nature. Whatever discoveries, and explanations, and predictions have been made concerning cosmical bodies, have really been made from the analogies presented to observation, and not surely from a cause of motion which no one has yet shown to be a "true and sufficient" cause of any motion.

Gra. But are not the motions of the cosmical bodies undeniable proofs of its existence?

Ment. The existence of what?

Gra. The existence of gravity.

Ment. They cannot be proofs of the existence of something you know not what. They are proofs sufficient of the existence of the forces which produce them. But what are those forces?

Gra. Hold there. Have you not fallen into the very error of which you accuse me? You have

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maintained that you have sufficient proof of the existence of forces, of the nature of which you confess your ignorance.

Ment. I speak only of forces in general. You allude to one individual force. You assume first, that it is defined as to its character; and second, you tacitly pretend to have discovered a particular force or principle, upon the character of which, you dare not, for the ignorance of you, condescend. It is here where the strength and the weakness of gravitation lie. Gravitation claims to be regarded as a particular force; and we cannot deny that there are cosmical forces; then when we examine, to ascertain the nature of this force, gravitation shifts the ground, and in the words of Newton, claims to be only any force in general by which bodies are made to approach each other; and still we cannot deny that there are such forces. But observe, the term gravitation is generic; and we shall not have arrived at any really practical knowledge, in respect of the causes of cosmical motion, until we have discovered individual or concrete forces. It will not do to close up this question by proposing a mystery, and putting an interdict upon inquiry; but to prosecute this digression further would require much longer time than we can now devote to it. We should require to consider the whole subject of falling bodies, the tides, the lunar and planetary orbits, the doctrine of perturbation, the method of find-

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ing the amount of matter in the planets, whether matter possesses an inherent power of action, and whether the laws of the human mind can admit the existence of such a power, with other particulars; enough, however, has, I think, been suggested to show you, that unless you can point out, or set before your own mind, how repulsion as a known and determined force is capable of ejecting particles from bodies, you have no warrant to affirm its competency. You must perceive its competency; at least as much so, as we may be said to know the competency of impulse as a motive agency. We observe the cosmical motions; but how do we know that what any one calls attraction is the necessary antecedent of these motions? In fact, until you have arrived at a cause which is some object of thought, and not a mere abstraction, and which you can believe to be adequate to the assigned effect, you have arrived at no cause which is anything to the purpose.

Gra. But you will not deny that light is dispersed from any radiant point, and that some force is requisite to its dispersion; and since the result seems very obviously to necessitate such a cause as repulsion, why may not the real cause, whatever it is, be designated by the term repulsion, as well as by any other?

Ment. It is clear that such terms as repulsion and attraction are the abstract or hypothetical names of

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certain concrete physical agencies, which ought to be the real objects of science: and are not common people apt to imagine, that when philosophers use a term like repulsion, they signify some precise force by it—some agent of a definite and known character? And does not this tend to prevent any further inquiry? And, moreover, has not the use of such terms as repulsion and attraction led us tacitly into the belief, that matter possesses an unborrowed power of producing motion, derived from no antecedent notion, which is contrary to our most trustworthy experience.

Gra. As I place little reliance upon the judgment of a critic who finds faults without being able to mend them, so neither can I regard that man as a philosopher, who attempts to overturn the general opinion, without substituting one more in accordance with reality. The true refutation of falsehood and error, is the substitution of truth and right. What cause, then, do you propose for projecting the luminous particles?

Ment. If you regard these particles as being a peculiar species of matter resident in the structure of ordinary forms of matter, I can see no reason for entertaining a belief in the existence of any such particles; and you ought to consider, as I said also to Sylvius, that if ordinary matter in any way has a motion capable of ejecting luminous particles, why not fall back at once upon ordinary matter, of whose

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existence, as a sensible object, we are perfectly certain? Tell me any effect which can be produced either by a peculiar species of particles, or by an ethereal fluid, which some possible form of ordinary matter is not better capable of producing?

Gra. You seem to speak as if there were but one universal element, out of which all other forms are modified: do you not admit that the particles of any two of the chemical elements are different kinds or species of matter? And if they be so, what hinders the existence of specific particles for so important a purpose as that of illuminating the universe?

Ment. You entirely mistake me, if you suppose that I hold the notion which has been entertained by some, of but one ultimate element. Were there but one element, it is difficult to see in what way it could assume different forms. Gold melted into gold can only retain the same form; but what I mean by saying that the elements of the chemist are all one kind of matter, is simply, that the matter of these elements can combine to form those generally compound substances, which I call ordinary matter. But specific particles, which are mere lodgers, and have no family-tie binding them to ordinary forms, but are beyond the manipulation of the chemist, I call a different kind of matter; that is, upon the assumption of the existence of any such. Forms of ordinary matter, or the elements of these, have been

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compared to the letters of the alphabet. They may unite together in various ways, to form or represent one language; but a wavy line (~~~) like this traced by my pencil, may be compared to your specific particles and ethers: it will not combine with any of the letters of our alphabet to form a word. But you have not answered my principal question: you have not shown that your specific particles or ethers are capable of producing effects beyond the avocations of ordinary matter.

Syl. There is no form of ordinary matter tenuous enough for purposes of vision. It is admitted that ordinary matter may assume a solid—

Ment. More properly fixed.

Syl. Well, let it be so. Matter may assume a fixed, a fluid, and a gaseous, form, and considerable varieties in each of these; and it is held that all matter, properly called matter, may assume these forms; but which of them all is tenuous enough to penetrate the lenses of the eye, and produce vision?

Ment. I do not say that any of these is tenuous enough for that purpose; but what do you say to the doctrine of a still more attenuated form than any of these? You admit tangible, fluid, and gaseous forms of ordinary matter, what objection have you to what I have taken the liberty of calling the opticable form of this same ordinary matter?

Gra. Although, as you stated, Sir Isaac's question contains the germ of this notion, yet it never struck

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me before in the same light; and, in truth, I can see no objection to this doctrine, since, undeniably, there is an opticable form of matter, and since it is evidently possible for ordinary matter to assume any form which, in virtue of hypothesis, we can legitimately demand for luminiferous particles, or for a subtile ether. And if light be merely the most tenuous form which ordinary matter is capable of occupying, the material world thus regarded will certainly have become a much more practical problem than it has hitherto been, and one more cognate to the faculties of the human understanding.

Syl. But how can ordinary matter possess the quality requisite for producing luminosity?

Ment. I stated already that luminosity is not a quality of matter; no, not even of that form which subserves vision, any more than tangibility is a quality of matter; it is only an effect, and implies merely the relation in which matter stands to our sense of vision. This you will find laid down by Hobbes, and by Descartes, I am told, and still more fully by Locke, where he treats of what have been called the secondary qualities of bodies.

Syl. But how will you any better prove the reality of this opticable form than I can prove the existence of a universal ether?

Ment. You lay down your ether by what is called hypothesis, or anticipation of Nature. I proceed by induction, examine phenomena, and give you my in-

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terpretation. It may be wrong, or it may be right; but the reasons for holding the visual form of matter to be a form of ordinary matter, and not an isolated fluid, are at least what may be called inductive reasons.

Gra. I agree in what Mentor has said; and provided he can show an intelligible cause of motion, as you, Sylvius, desired him to do, in this ethereal form of ordinary matter, apart from repulsion, I shall have no hesitation in accepting his interpretation of the relationship of light to other forms of matter; for it appears to me to make matter a much more practical thing than it has hitherto seemed, and can in no way affect the Newtonian optics.

Ment. But I have not yet shown you some of the proofs, in deference to which I hold the universe to be a blood-related family of reciprocating forms.

Syl. But even if you show that light is a form of common matter, that will by no means prove the material world such a unity as you speak of. There are the electric, magnetic, calorific, and various other imponderables, which, even after all the experiments of Oersted, Faraday, and others, can hardly yet be admitted to be the same as light.

Ment. Well, now, let us consider this. Of course, if we hold with Sir H. Davy, and those who adopt similar views, that heat, for example, is a feeling consequent on a peculiar molecular motion of com-

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mon matter, we can have no dispute. But if we take the theory of a calorific fluid, then, let me inquire of you, Sylvius, what you mean by the question you implied, as to whether light and heat, as external agents, be the same?

Syl. That question must certainly have a meaning. Its solution has occupied the attention of some of the most celebrated physicists. To me the meaning of it is this;—since the effects called vision, and those called heat, are not the same—are not productive of the same ideas, the question is, are the causes of these different effects one object, or two objects differing from each other?

Ment. But a bell and the air, when they strike the sense of feeling, produce effects different from those they produce when they affect the sense of hearing; and yet the chemical or elemental character of the bodies are permanent. What, then, is it you expect to find differing in the caloric and visual media?

Syl. When we find different effects produced it is a universal maxim of reasoning to infer different causes.

Ment. This maxim cannot be entertained. What J. S. Mill calls the plurality of causes, exhibits a principle which shows, that the same effect may have different causes; consequently the same cause may produce different effects: more especially if the tests which external causes act upon are dif-

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ferent from each other, as in the case of our senses; we have no right to infer that these objective causes are essentially different. In general I have a right to infer that what produces in me the sensation of red, is different from that which produces the sensation of blue, because both causes act upon the same test. But when a body, such as caloric is held to be, acts upon what may be called the thermic sense (as being clearly distinguishable from feeling proper); and when a body, such as the visual medium, acts upon the optic nerve, or choroid, or whatever is the seat of vision, although the conscious effects may be different in the two cases, we are not warranted to draw the inference of a diversity of cause.

Syl. Do you mean to say, then, that such men as I could easily name, have expended their energies upon a question which is really no question?

Ment. I would not without the utmost caution assert this; but I am afraid no other course is open, unless you can tell me what that is in the visual medium, or the magnetic, or electric fluid, which is different from, or the same as, something in caloric. One parcel of matter may be made to assume a variety of forms, and acting under a variety of circumstances, may be made to produce a great variety of effects, and yet be all the while the same matter. So may electricity, magnetism, galvanism, caloric, light, be the same matter acting under different cir-

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cumstances, and upon different tests; for the effects produced by light do not at all show that the same matter may not produce heat. That a certain parcel of matter produces light, no more disqualifies it from producing heat, than that a parcel patent to feeling, is thereby disqualified from affecting taste; the fact, indeed, that any matter affects one sense proves, rather than disproves, that it may affect another sense. At any rate you can never show light and caloric to be different, so long as you cannot penetrate into their essence, but must judge of them by the effects they produce.

Syl. But if you cannot show them to be different, neither can you show them to be the same; and, moreover, upon these grounds you might argue, that because we cannot judge of oxygen in itself, and chlorine in itself, we have no right to assert that they are different.

Ment. But we can apply the same test to each of these; and when we do apply a test, we find a result in the one case different from what we find in the other. No doubt we judge by these effects, and cannot penetrate into other supposed qualities in these gases; but in the case of light and heat we can only apply different tests, from which, difference of cause cannot be inferred. You may tell me that we can apply a thermometer to the various rays of the spectrum, and that we find certain rays to give more heat than others. But this is mere hypothesis.

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All that we find is the greater or less expansion of the thermometric test; and as there can be no such thing as heat in an insensible object, we can only infer that one kind of ray combines more rapidly or largely with the mercury or other test, than another, or is less rapidly given off in insensible channels. But this will by no means prove that what expanded the thermometric test cannot affect our sense of vision. That a certain parcel of matter which affects our thermic sense, is thereby rendered incapable of affecting our sense of vision, is, as I said, no more to be inferred, than that a parcel of matter which affects our sense of taste cannot affect our sense of feeling. A variety of elements has been conceded; and although hydrogen and oxygen, for example, may be different in themselves, they yet stand in such an elemental relation as enables them to combine and produce new forms; and what I want to bring before you is the conception, that all forms of matter whatever, stand in this kindred relation to one another. I admit, that restricting our view to light and caloric themselves, we cannot prove their identity; and, in fact, rigidly considered, there is no question here involved. For the effects called heat, and those called light, are incommensurable, and indicate no repugnance in their causes; but from the general analogy of Nature, and the logical restrictions under which matter must be viewed, no other conclusion can be come to than,

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that these and all other possible forms of matter are elementally reciprocal. The utmost confusion has arisen from speaking of matter as heat, or as light. In the external world there are only forms of matter; and to say that because one ray of the spectrum expands mercury more than another there is more heat in it, is the same as if I should say there is more matter in a pound of wheat than in a pound of husks, because a greater quantity of the wheat than of the husks can be assimilated by the tissues of my body; but since we have not time to discuss the whole subject of the reciprocity of general forms, let us confine our view to the visual medium as a type of such fluids as are supposed to be a kind of matter alien to the common stock. And if we can show evidence for regarding this fluid as a form of ordinary matter, little ground will remain for holding the less notable imponderables—magnetism, electricity, caloric, and such like, as specific bodies.

Syl. Well, I shall admit that if you can show the visual medium to be no more than the most attenuated form of ordinary matter, I shall not very obstinately stand out for the specific character of the others.

Ment. If it be permissable to take a single *à priori* glance at the subject, ought we not rather to expect the material world to be a unity, that is, that one grand aggregate, of what we may call

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marriageable elements, should be adequate to all desired purposes, than that fluids, otherwise idle, should have to be introduced for little other purpose than animal vision? For we cannot but conclude *à posteriori*, that ordinary matter, of whose existence we are certain, is capable of assuming a condition as attenuated, as an ether whose existence is really superfluous. He who said that had he been consulted at the creation, he would have prevented the commission of some absurdities, undoubtedly spoke a truth in respect of much which the ignorance of man has put to account of the wisdom of the Creator. And I would ask you, would it not have been better to have created matter capable of assuming when necessary, such a form as might serve for purposes of vision, than to have created a special ether for these purposes?

Syl. But light supplies many other purposes besides those of vision.

Ment. Undoubtedly a universal ether was invented (by Huyghens, or whoever has the merit of the invention) solely as an instrument of vision. For those effects of composition and disintegration, which we find taking place in respect of natural objects, animate and inanimate, which are exposed to light, would never have suggested the existence of a fluid having no elemental relation to these natural bodies. I admit that vision is but, as it were, an incidental result of the existence of light,

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and that other equally important ends are served by it; but I can admit this only on the ground that light is elementally akin to those forms in which it produces the effects spoken of. These effects may prove the existence of light, but they certainly do not prove it to be a specific ether; but prove rather that it is a form of matter capable of assuming other forms or phases of aggregation.

Gra. I am anxious, Mentor, that you should proceed. For, if you can prove your doctrine, I begin to foresee some of the extraordinary consequences which will result from it. But whether you prove it or not, I shall not think the discussion useless, which has brought forward a hypothesis, which, to say the least of it, gives a most wonderful connection to all the objects of Nature.

Ment. Let us first take a slight view of the transmutations of material forms.

Syl. Do you mean to assert that one body may be transmuted into another?

Ment. No, I do not hold the venerable doctrine your question suggests. For to me the bare fact of a difference in form or consistency (not geometrical form) is a proof of difference in ultimate chemical constitution. And this, by the bye, might have led chemists to suspect the perfection of their mode of analysis, which is unable to detect a difference between, for example, ice and water. Undoubtedly there is a difference in the balance of

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elements of ice and water, which is the foundation of the sensible difference between the two. Another error of analysis, resting on a false assumption, is the frequent reduction of bodies to a different state before testing. And the false assumption here is, that bodies can exist in different states, be thrown into different conditions. Whenever a body is put into a new state or condition, it is chemically a new body; for this new state can only be superinduced by the application of foreign elements. The doctrine, therefore, in its popular acceptation, that all bodies can exist in three distinct forms, is erroneous; a body can only exist in one form; when it changes its form, it is really a different body—for changes of bodies can only result from the taking up of new positions by those ultimate matters or elements of which bodies are composed. And this is agreeable to what Sir H. Davy says respecting carbon and the diamond.

Gra. Do you mean then that when a solid is reduced to a liquid, it is not the same aggregation of matter, as it was in the previous state?

Ment. Yes, precisely. Nor will chemistry get out of mystery, until it recognise the simple principle, that all changes of forms alike result from new elemental combination, and not in any case from the action of imponderables moving behind the scenes. When a liquid form has been reduced to a gaseous, something has been added or subtracted. The vo-

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lume in question is not now the same chemical compound. And thus, because a certain amount of a given form of matter requires the addition of a certain amount of another form to alter its consistency, the whole universe of matter can never assume one form. For here, as in other cases, action and reaction are equal. And the matter which has been rendered into any form is continually passing into others.

Gra. This I hope will become clearer, when you have shown us in what way light is derived from ordinary matter.

Ment. First, then, let us consider the subject as a question of transmutation of material forms: and to get as much as possible beyond the influence of prejudice, let us enter the temple of Nature, as it were, for the first time. We behold a great number of objects; some fixed, some liquid, some gaseous: and we find that there is one form, through whose agency the others are seen. We proceed in our investigation, and find that none of these objects permanently occupies the first form in which we beheld it. The fixed body has been decomposed, and has become liquid, or gaseous. The liquid has entered into combination with some foreign element, and has taken up a fixed position. The gaseous body has become a portion of a liquid, or of a fixed form. We stand still for a moment, and speedily find the whole process reversed; and what is most remarkable is, that

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there seems to be a common fund of elements, equally ready under certain circumstances to give birth to either of the forms we are considering.

Syl. But we have not found any of these forms giving birth to light.

Ment. That remains to be seen. Let us take, for example, a forest of the carboniferous era. The great ferns, the equisetaceæ, the club-mosses and other cryptogamia and monocotyledons, the conditions of whose existence seem to have marched by upon the long journey of time, and to have left the world, grow up by assimilating the matter of surrounding forms, fixed, liquid, gaseous, and doubtless the higher forms of which we are in search. Time passes on, and that sublime process, which science has not yet investigated, and which underlies all the phenomena of physical change and cosmical movement, sweeps insidiously on, and the once green forest is converted into a stratum of coal. Time passes on. Man appears: he invents destructive distillation. He converts a portion of the matter of our primeval forest back again into the gaseous form which, at a former period, it mainly occupied. But he institutes another process with this gaseous form, and a portion of it is converted into a form tenuous enough to reveal to our vision all the parts of this circle of transmutation. Such, at least, appears to be true, before we are instructed in the hypothesis of extraordinary ethers. One of the forms of matter

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is the medium by which the others are rendered visible.

Syl. But, although the combustion of the gas gives occasion to an evolution of light, where is your proof that that light is elementally related to the matter of the gas? When the products of this combustion are collected, they are found to weigh the same amount as the gas and atmospheric constituents which have entered into combination.

Ment. Or at least you might have added, if they are not found to weigh as much, an addition is made for necessary loss in manipulation. But the small amount of fixed or gaseous matter required to produce an enormous volume of the opticable form, may be inferred from the fact, that a quantity of a burning candle which is all but inappreciable, will produce a volume of the opticable form of matter, filling a space of several miles radius, and at the same time producing other products: for perhaps in no combustion with which we are acquainted, are the whole of the combining bodies converted into the form which produces vision. In an ordinary fire, various fixed and gaseous products result. And the same is the case in many other chemical combinations. And combustion seems to be nothing more recondite than any ordinary combination. This phenomenon is called combustion, because one result of the combination is, to produce that form of matter which affects our optic and thermic senses.

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Combustion is simply such a combination as may produce the most attenuated form of matter. Nor do we stand in need here of a new principle of interpreting material combination or its results, nor of any subtile ethers. The combination of the carburetted hydrogen, and the oxygen of the atmosphere, with a portion of the visual form, involves a ratio of elements, giving birth to a certain amount of that body, which, as it suddenly passes by on its physical mission through the universe, intimates its progress to animal vision. And there is doubtless a deeper reason why we love to open our eyes, than the beholding the beauties prodigally luxuriating around us. We are dependent upon external agencies. And into what a profound intimacy do we come with this material system, when we find that the eye, ever turned towards the light, is the primary conduit through which material forms actuate the nervous mechanism of man.

Syl. But you have not answered my question,—how do you prove that this ethereal form is elementally akin to the matter of the gas and the oxygen?

Ment. How do you prove that the gas is elementally akin to the coals? You find that the one issues out of the other; and I find that the opticable form issues out of the gas. And not knowing of any other *materia subtilis* being there, I infer that this matter which has acted on my sense of vision, must be some new form of the matter which has already

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undergone so many transformations. It is this highest form which opens up the material vista to our observation; and yet you would deny it the character of matter altogether. You must admit that it is an act of ordinary matter which enables us to see matter. Where, then, is the foundation of your inference in favour of a specific ether? And if an analogy between the modes of motion of the media of seeing and hearing is to be admitted, we ought, as the just ground of that analogy, to admit, that since the medium of hearing is some form of ordinary matter, so also must be the medium of seeing. But, in truth, it has never been argued that the ethereal medium is not a form of common matter. The subject seems merely not to have been investigated. But what right has any one to infer from phenomena of ordinary matter the existence of extraordinary matter? It is a strange mode of arguing, to say that ordinary matter has not capability to produce vision, and then to introduce something to supply the desideratum, which, so far as your positive knowledge extends, has neither capability nor existence. You put an end to the investigation of matter by *making* an ether capable of vision; but this is not the way to build up science. And even when I grant you the existence of an ether, it is still but an inference which attributes vision to acts of that ether. And the question comes to be, whether is my inference that vision results from a

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form of ordinary matter, or yours, that it results from the combined action of ordinary matter and ethereal fluids, the best supported? I have abundant testimony of the capacity of ordinary matter to produce sensible effects. You must grant your agent a bill of rights before it has any power at all; and even then it is helpless and dependent. It must call for the assistance of ordinary matter. And even this ether must have so many of the attributes of ordinary matter, as might excuse one for confounding the two. It must have impenetrability, else one portion could not move another. It must have impulse for the same reason. It must have weight, which is but the measure of impulse. And phenomena of ordinary matter, which alone come under cognisance, can never justify you in setting the capability of that very matter aside. It is from the very ability of matter that you infer its inability. And is it not more probable, when we say an ethereal medium is requisite to vision, that man's knowledge of ordinary matter is defective, than that ordinary matter requires to be supplemented? And if you feel no scruple in bestowing upon an ether of *your* creation a capacity to produce vision, why should you deny that Nature has bestowed on the matter she has created, this optical capacity? Do we *know* that ordinary matter wants this capacity? or do we *know* that an additional ether is required? Are we ignorant concerning ordinary

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matter? or are we learned concerning subtile ethers? We can only be justified in assuming an ether when all the possible capabilities of ordinary matter are known to be fruitlessly exhausted. And do we possess this knowledge? Certainly, if ordinary matter embrace the capacity of taking a form sufficiently attenuated for vision, you would never resort to the expedient of an extraordinary ether. We do not, indeed, know that matter is capable of infinite attenuation; but the fact that we do not know that it is not, shows that it may assume a very superlative degree of attenuation. And it is only a high degree of attenuation in matter that vision requires—not a specific ether; you cannot, therefore, assert that ordinary matter is *not* capable of the attenuation requisite to optical phenomena; and all the analogies of sensation and transmutation affirm that it is. So that the case stands thus:—Of the existence of ordinary matter we are certain. Experimentally, we are also certain of its being capable of a degree of attenuation, under which it becomes inappreciable. It is only in a logical point of view that an ether can be contemplated, since it is a medium, but not a sensible object. It may be an object of reason, but not of perception. And this seems to be the metaphysical reason why the medium of vision has been regarded as something different in essence from those forms of matter whose objective existence it serves to reveal, while

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itself being the highest medium of perception, cannot mediately come under sensible scrutiny. But in this logical point of view a specific ether has no advantage over ordinary matter; concerning which, no known contradiction is involved in saying it may become as tenuous as any ether; and, therefore, since matter exists, and is capable experimentally of a high degree of attenuation, and logically of that degree required to vision, it certainly has claims above an agent, whose existence and capability must both be assumed. Of course I hold that the very fact of vision proves experimentally, that ordinary matter may assume a form, tenuous enough for vision; but I do not press the argument from this ground, because it might justly be charged as a begging of the question. But since it must be the motion of some form of ordinary matter which gives motion to an ether, if any such exist, and since no known motion of any gaseous form can originate this motion, there must be some more attenuated form of ordinary matter than any gaseous form for moving the ether; in short, there must be an ethereal form of common matter, which renders a specific ether entirely unnecessary. And since *it* is judged capable of giving motion to an ether, it must have the required motion itself, so that ordinary matter may assume the form and the motion required to a medium of vision. And since I know of no specific ethereal medium I am driven to that

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interpretation I have stated, in order to avoid all hypotheses. I need no specific fluids. They would utterly mar the problem. Ordinary matter seems entirely adequate to all the phenomena. We know that ordinary matter in many forms is capable of affecting our senses; but of the capability of an ether having no chemical relation to the matter of which our organs of sense are constructed, we have no knowledge; and, besides, as I think was already stated, it is as easy in a logical point of view—in which alone an ether can be considered—for ordinary matter to occupy transiently an opticable form, as it is for any isolated matter constantly to occupy that form; for it is because you are able to conceive of ordinary matter as occupying such a form, that you are able to conceive of an ether. If you deny that ordinary matter can occupy such a form, you in strict logical reality deny the possibility of an ethereal medium altogether—you deny that matter *can* occupy this form; and matter here must mean ordinary matter, of which alone you have had experience; and if you admit that matter can occupy such a form, my point is gained. And since we never see the phenomena of light exhibited to any considerable extent on our earth, where the decomposition or change of some form is not taking place, we are further warranted in concluding that the visual medium is a form of other forms.

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Syl. But I can show by analysis that the matter of the gas is the same as the matter of the coal; whereas you cannot show that the matter of your visual form is the same as that of the gas.

Ment. Of course you do not mean that, by analysis, or in any other way, you can penetrate to innate qualities in material forms; you mean that the matter of coal and the matter of its gas will produce similar effects, or stand in the same relation to some test. But then you have to consider that the opticable form derived from the gas is too much attenuated to be analysed by the same test. But I apply the test of general sensation, the legitimacy of which I maintain, and find that the opticable form has the property of producing a sensation. From sensation alone we learn the existence of matter; therefore, that which produces sensation is matter, and not specific ethers. Setting vision and thermic feeling aside, all our other sensations are produced by various forms of what we call matter; nor can there be any good reason to exclude the sensations of seeing from the acts of this same matter, when, undeniably, it is more capable of producing them than any specific ether can be: only, I have no objection to your calling the medium of vision an ethereal medium still, provided you recognise its elemental relationship to common matter. Nor will this recognition include anything in it militating against the fitness of such a medium, as an instru-

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ment of vision. An ethereal medium, elementally the same as the media of hearing, feeling, tasting, smelling, is at least as adequate to supply the sense of seeing, as an ethereal medium of a nature which the very limitations imposed upon language by our organs of observation do in fact preclude us from ever really speaking of. And even if it be admitted that the visual medium is a form of common matter, you will agree with me that it is of too volatile a nature to be patent to such tests as are available for tangible forms. But that it is composed of a certain ratio of the elemental matters of which all forms are composed, is the only intelligible explanation which can be given of those effects taking place in its presence upon bodies more scrutable by ordinary observation. And the continual changes transpiring before us emphatically point out, in a manner it seems strange we should so long have overlooked, that there is a grand physical, as well as a mechanical, process going forward in the solar system. Without the introduction of new matter into our globe, not a single change or disturbance can be connected with an intelligible chain of phenomenal sequences. But this introduction of a form so attenuated as the medium of vision, once admitted, the long periods requisite to account for geognostic results will become facts which reason may learn to manipulate.

Gra. But how will any form of opaque matter produce luminosity?

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Ment. Light, whatever it be, does not produce luminosity. That is a result of the relation established between an organ of vision and a form of matter. Light indeed may, if you like paradox, be considered the darkest of all bodies, being that by which others are rendered visible, while itself remains for ever unseen. And here, by-the-bye, we may note the necessary limitation of the microscope, under that view of the correlation of forms which I adopt. It has been imagined that microscopes might yet be invented capable of rendering visible the ultimate atoms of matter. But here we find that these ultimate atoms themselves constitute the medium of vision. I do not enter into the question of ultimate atoms, but only of an ultimate form. And it is by virtue of one of the forms which matter assumes that its other forms are seen. But I will engage to show you the ultimate atoms or form of matter, whenever you give me a medium of vision different from these atoms.

Syl. But even upon your own hypothesis will not the universe be still filled with an ethereal medium, thrown out from the various astral centres?

Ment. It will. But then this medium, though it may undulate, or move in straight lines, according to circumstances, is not a great stagnant, tremulous sea; it is a form of common matter able to take part in all cosmical processes. It is one of the members of the material family. It is not an alien, and

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mere on-looker. It is constantly migrating into new forms. And how this doctrine will serve to clear our views respecting geognostic causes on our globe, and many other cosmical phenomena, including even the cosmogony itself, we have not time even to glance at.

Gra. Sir John Herschel has pointed out the beautiful "family likeness" existing among the members of our solar system, revealed by Kepler's third and more magnificent law; and the family tie which you indicate as connecting the material universe is, perhaps, no less important; for I perceive, from what you have said, that we must regard all matter as being essentially one community throughout the visible universe. For the bare fact that a star is seen, is proof that it is composed of matter kindred to that of our own globe.

Ment. That is quite true. We can by no means enter at present into the large question of the decomposition of astral bodies, and their consequent diffusion through space, and the necessary developement and growth and production of other similar bodies from their materials, which constitute the great process of which all other processes are but results. This would introduce us, as I said, to the subject of the cosmogony, which Hutton and Sir Charles Lyell regard as beyond the province of science, and which Playfair, in his explanations of the former, asserts to be unconnected with any pre-

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sently existing laws, or any indications we perceive; but which, if our view be correct, will be the grand problem of science, the sole thing which is perceived. But into this we cannot enter. Let it suffice, that we must regard all the globes of space as essentially similar in their elements, so long as we search for them by the light they diffuse. And if all matter be cognate, our bodies are in some measure indebted to that which hath entered our eyes from the deepest gauges of the milky-way. We are formed not only of the dust of the earth, but also of the dust of the sun and stars.

Gra. But how can you regard the matter of our various planets as being the same in all, when some of these planets are found to be as light as cork, and some as dense as lead?

Ment. This is not found; it is a consequence of the theory of innate attraction. The motions and deflections of the satellites, on which this conclusion rests, are no more dependent on the density of their primaries, than the motions of these primaries are dependent on these same densities. All these motions alike depend upon the position of the bodies, in respect of the centre of the system. The rate of deflection of a satellite is dependent on the rate of motion in its primary. So that when we find all the planets being developed under similar influences, we may, till we find some proof of the contrary, regard them all as being of nearly equal compactness.

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Syl. But might not the light of one star be different from that of another?

Ment. No doubt it might. The light of one star might have the red ray predominating, and another the blue. But as these colours, or rather sensations, are our ultimate test of the quality of light, whatever light produces these sensations must be regarded as elementally akin to solar light.

Gra. But if gross bodies be convertible into light, as in combustion, will not light be reconvertible into gross bodies?

Ment. Undoubtedly it will. It has been usual to consider the function of light, in regard to animal, vegetable, mineral, and other structures, as that of a stimulant, a cause exciting the activity of composition and decomposition in ordinary matter. For my part, I cannot very clearly understand wherein the ability of stimulation should exist—in a specific ether, or in specific particles. But if light be regarded as nothing more than the most attenuated form of the same matter as all bodies are composed of, its functions are as intelligible as those of air or water. The sun cannot shine upon any body without changing its molecular arrangement. Animals cannot, without sufficient light, attain to their proper developement. Without this form of matter plants do not arrive at their perfection. Upon its application to photographic preparations their constitution is instantly changed. All bodies being but forms

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of this same matter are necessarily coloured. And these, and a thousand other circumstances which I have had to review in arriving at this interpretation of Nature, lead me to believe that these circumstances receive by this interpretation a clear and intelligible solution, which the doctrine of specific ethers can never bestow. We can easily understand why the introduction into a body of new elements assimilable to its own, should affect its structure; but how an ether, between which and ordinary bodies no elemental tie exists, should affect these bodies, or what could be the intelligible mission of such an ether in this world or anywhere else, I confess my entire ignorance. And why, in any case of change of chemical constitution, should we controvert that broad practical analogy, founded upon what, but for this assumed exception, is a universal induction, which affirms that all such change results from admixture of cognate elements? When we see an oxide formed upon iron, for example, by the action of the air, we admit that the air has combined with the iron to produce the new compound. But when we see light effect a change on any preparation of silver, we change ground and resort to excitements, which bring nothing but mystery. The explanation is too simple which holds, as in the first example, that the form which incidentally affects our eyes, has entered into combination with the silver. A blind man, who can only regard this

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medium apart from the idea of luminosity, and as being simply a very tenuous form of matter, will have much less difficulty in conceiving of its capability of combining with other forms, than one who, from the prejudices of sight, imagines that luminosity puts a distinction in species between light and other forms. In fact, when we shut our eyes, and conceive of this form, as running to and fro continually, and having (from the absence of vision) the same physical nature as other thin fluids, we have no longer any reason to resist the belief that, like all other forms, it is capable of chemical union.

In the second place, if we look for a moment at this question of the correlationship of forms, in respect of the senses, we must come to the same conclusion. When a given parcel of matter is admittedly capable of affecting our senses of smelling, tasting, hearing, and feeling, is it not more probable that the same parcel, or part of it, in one of its possible forms, may also affect our sense of seeing, than that an irrelated ether should be required? Our senses do not penetrate into any qualities of material forms, we are only acquainted with effects; and therefore a peculiar kind of matter is not desiderated in vision, but only matter in such a form of attenuation as shall be able to penetrate the lenses of the eye. Feeling does not require a peculiar kind of matter for its exercise, but only matter in a peculiar form of aggregation; and so of hearing, tasting, and smelling. Supposing that we were en-

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tirely ignorant that plants are continually absorbing new matter, and throwing out that which is effete, might we not build a hypothesis upon this ignorance, and say that a subtile medium existed, which plants put into a state of agitation, and which, coming in contact with our olfactory nerves, produced by various rates of vibration, the various odours we experience? This hypothesis would be as good, and I believe as true, as that which introduces specific media for purposes of vision; but the fact that the opticable form of matter is capable of producing sensation, is in itself a proof, that this form is a form of that matter whose power of producing sensation we are already aware of; nor does the circumstance that a form of ordinary matter is capable of subserving vision, render that form any the less fitted for magnetic or electric purposes. Indeed, there is nothing in what has been said to contradict the possibility, that the matter of magnetic experiments may be a different ratio of elements from that which produces vision; but although this should be so, there is no probability that either of these forms is anything but a form of the ultimate cosmical elements; nor could any specific ether accomplish anything which is not equally within the reach of a possible form of ordinary matter; and an undulatory, or any other mode of motion, in a form of matter, cannot afford the least clue to its chemical character, its elemental relationship. In fact, if we would go to the logical root of this subject, we

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should find that our sole possible, positive definition of matter, is that which affects sense; and then because the opticable form is a form which may affect our sense, we must conclude this form to be the same kind of matter as we had defined.

Syl. But did you not assert that we could not intelligibly speak of a specific ether? And is not the fact notorious that the whole scientific world uses this language?

Ment. This fact is by no means so notorious as the fact, that thousands speak of ghosts and fairies; and yet we do not admit that they actually speak of objective and independent beings. A specific ether is a creature of scientific superstition. In as far as there is anything true, which we affirm respecting ghosts or fairies, the facts relate to observed phenomena. It is from distorted combinations of these that such spiritual creations spring up. In like manner, whatever is true of a specific ether, actually refers to phenomena we have experienced in ordinary sensible matter.

Syl. But it strikes me that in almost all that you have said, you have advanced nothing really repugnant to the undulatory theory of light.

Gra. Nor to the emissary.

Syl. Your medium, Mentor, may vibrate; and as to the ultimate constitution of the ethereal medium in the undulatory theory, it is not really in question.

Ment. You are perfectly right. I have no real

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controversy with either of the rival hypotheses of light. It is the nature of the visual medium I enquire into, not the phenomena of optics. Doubtless the view I adopt would introduce some modification in several optical details. For example, polarization by reflection might be explained by saying that when light—a form of ordinary matter—falls upon a body in a certain manner, a peculiar portion of it is absorbed, leaving the constitution of the reflected ray different from that of the incident. And as regards absorption, which Sir David Brewster is persuaded will yet be found important in explicating optical phenomena, we are not to regard the absorbed light as remaining in bodies in the character of an imponderable alien. Why should it not become a part of the body into which it enters? Different bodies absorb different amounts of the three rays (the matter of which three rays is, perhaps, to be regarded as exhibiting a certain ratio of the ultimate three elements of all matter); but as all bodies are in a continual state of flux, it is no more to be inferred that the absorption of light by a body should render that body heavier, than that a man should grow continually heavier from the taking of food. The food we eat is thrown out in ways, some of which are insensible to ordinary observation, and it is not at all necessary that light in passing out of a body, should produce vision; for vision is but an accidental result of the existence of light. Unless light be moving with a certain velo-

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city, and in a certain amount, it will no more produce vision than a piece of a tangible form which never comes into contact with our muscular sense will produce feeling. Grove, in his essay on the *Correlation of Physical Forces*, ridicules Moser's idea of "invisible light," and calls it a contradiction in terms. But in the view I adopt, invisible light is no more a contradiction in terms than unfelt tangible bodies.

Syl. But you objected to the undulatory theory, that no cause of undulation could be pointed out. Now, what is the cause of motion in your opticable form of ordinary matter?

Ment. You remind me of an objection to the undulatory ether, which I forgot to state. Why, if the mere undulation of any medium cause light, do not birds flying by night leave a trail of light behind them? Of course you will tell me their motion is not rapid enough. And if I say cannon-balls do not give the necessary agitation for producing light, you will make the same reply. But this you do, just because no luminous effect is produced by these motions; for you cannot know why these bodies, moving through your supposed ether, do not agitate it sufficiently, until you can clearly point out what motions of ordinary bodies *are* sufficient. But to return to your question. Let us ask, what is the cause of motion in any form of ordinary matter? A ship, for example, moves either from the pressure of air, or the expansion of

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steam: but why does the air move? and why does the steam expand? The steam expands, that is, radiates from a centre, because it is produced at that centre in greater quantity than in surrounding space. The water, from which it is chiefly derived, is converted into a form which occupies a larger volume, and expansion, that is, motion from a centre, is the necessary result. It obeys that law whose expression is, that gaseous bodies tend to a state of equi-diffusion. Nor is the principle by which air moves a ship different from that by which steam does so. It is the pressure of air into a vacuity which urges the ship directly; and, indirectly, the pressure of the steam into a vacuity effects the same end; and the vacuity caused by the rarefaction in the atmosphere is virtually the same state of things, as if surrounding air were there generated from a more condensed form of matter. Wherever the air is denser, it necessarily falls into places less densely occupied. A receiver, half emptied of an ordinary atmosphere, is still equally pervaded by air, because into the vacuity created by the pump, the remaining air falls.

Syl. But that does not inform us what is the real force which urges the steam and the air outward from a centre. Do you not require for that purpose a repulsive power in the particles, for example, of the steam?

Ment. To a certain extent I adopt the positive

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method of Comte; and I am not able to comprehend the nature of what you seem to imply by a repulsive power. I find no evidence of spontaneous activity in sensible objects; and such an illustration as that of a rotting leaf, given by Professor Nichol in favour of this spontaneous activity, proves the contrary. I cannot adopt a principle, or a power, or whatever you like to call it, unless I can in some way learn its adequacy. When I perceive a wedge driven into a piece of wood, I also perceive the parts of the wood to be separated; but in the expansion of steam I see no repulsive power: I only know that more steam is being constantly generated at the centre, and I can understand why this denser portion, like a wedge, should press back the more distant portions. Repulsive power is not really any inference. We have not arrived at the mode of the action by which particles kick each other out of each other's presence; for, as Berkeley says of attraction, which he calls the great mechanical principle now in vogue,—"I do not perceive that anything is signified besides the effect itself for as to the manner of the action whereby it is produced, or the cause which produces it, these are not so much as aimed at." I admit that some cause diffuses the particles of steam; but if science does not know how that cause operates, is it not great childishness in science to pretend to know, in virtue of the application of a word whose meaning has not been defined?

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Syl. But what has that to do with the cause of motion in light?

Ment. I wish to bring the cause of motion in light out of the region of repulsive powers and excitement of luminous bodies, and reduce it to the same law as that by which other tenuous forms are diffused. I will not take it upon me to say that I have stated exactly the real cause of the diffusion of steam, but let the remarks be taken as a description of a phenomenon: and, in conformity with this phenomenon, we may again revert to our illustration of the production of gas. When the gas arrives at the burner, if it be not lighted, it spreads itself in all possible directions, expanding from the point where it is in greatest density, and falling into spaces more vacuous. If we now put the gas into a state of combustion, it does not seem that any new law should be required to explain its diffusion in its new form: for let us regard it apart from the idea of luminosity—entirely due to our organs—and we shall only be contemplating a fluid rapidly produced in large quantities at a central point: and contemplated thus, as a dark fluid, we should not for a moment regard it as anything other than a novel form of the gas; nor should we think it necessary to invent any other cause for its diffusion than that which diffused the gas. Again: when a fixed form is reduced to a liquid, it necessarily (in general) expands, because it is the very nature of the new form to occupy a larger volume.

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But here the motion of expansion is comparatively sluggish. Convert now this liquid form into a gaseous, and its motion into a larger volume will be immensely more rapid than in the previous case. If, again, the gas be converted into what we call light, or the opticable form of matter—from its relation to our organs of vision—its motion of diffusion from the centre where it is generated, is enormously more rapid still than in the conversion of liquid into gas. Certain combinations of elements necessarily occupy certain forms. When the form to which we reduce matter is denser than the matter which is to compose it, the motion is towards a centre. When the form to which we reduce matter is rarer than the matter which is to compose it, the motion is necessarily centrifugal. The same law of diffusion seems competent in all cases. And, perhaps, we may be said to be able to describe rather than explain it; for we know not why matter in one form should occupy more or less space than in another form. But we find that when a fluid form is generated, and left unsupported or unconfined, it falls into places vacuous of that particular fluid. And the exosmic and endosmic movements of fluids show that one body may not fill the space it occupies, or at least may present vacuities to the particles of other bodies into which these necessarily fall, by the same law, and not by meaningless powers of attraction. And here we may note the circular character of that chain of

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sequences which constitutes the path of the phenomena of Nature. When that ratio of elements combines which produces the visual form, this form is diffused, and entering other forms, produces in them such changes of structure as give rise to various new forms and motions; and these again bring about those combinations which result in light; so that the universe, when once set a-going, possesses the character of a perpetual motion. The decomposition of the sun gives rise (as can be shown), not only to the motions of the planets, but in chief measure to the planets themselves. It is admitted by Sir J. Herschel that all geognostic and meteoric motions can be traced to solar radiation; and when we regard that radiation as consisting of a form of ordinary matter, this high authority acquires much additional force. It would occupy too long time to show you in what way a central force can produce tangential motion; but to give you some idea of it, suppose a small horizontal wheel set up in the centre of a large horizontal circle. Let that wheel represent the sun; let the large circle represent the orbit of a planet; let a series of teeth be formed on the outside of this circle; let a small pinion be formed to fit into these teeth, and having an upright shaft; round this shaft, and the wheel at the centre, let a band be fitted, and the centre be made to revolve. This revolution will cause the pinion to rotate on its axis, and also to revolve round the large circle.

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And if man can thus, without any primary launch, produce tangential motion by central forces, it will not be denied that Nature may surpass him in producing a mechanism of central force for the production of tangential motion. And if we admit that, to support the decomposition of the sun, a current of air-form matter sets from all surrounding space, this current will counteract the force of solar radiation exerted upon the planets, and maintain them in their orbits. This being here granted (as we cannot enter into the proofs), let us now suppose that the atmosphere of our earth, for example, absorbs the solar radiation more abundantly in the forenoon than in the afternoon. And this is no doubt the case, since the heat at the solid surface of the earth is greatest after the sun has passed the meridian. There will, therefore, be a greater force of solar radiation exerted on the afternoon side of a planet than on the forenoon side; so that the planet will be compelled to turn upon its axis. And because the tangential motion is the direct issue of the axial motion (as in the case of our wheel and pinion), it will, as matter of bare necessity, be in the same direction: and the amount of tangential motion thus generated will be greater, the nearer the planet is to the central force producing it, or the larger the angle is, which the diameter of the planet subtends with the centre of its motion. Thus the solar decomposition produces all the cosmical and geognostic motions of our globe

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It must also mature this globe and the other planets to the condition of solar centres. The power laid up in them will then be unfolded by decomposition (for the only power competent to matter resides in the impulse it may exert in passing out of one form of aggregation into another), and this decomposition will perpetuate and develope the motions of the satellites of these planets, and repeat the magnificent sequential circle of material phenomena.

Gra. But how will you account for reflection? Newton accounted for this, as for many other phenomena, by a repulsive power in bodies.

Ment. Newton was far more guarded than his interpreters. And when he spoke directly of repulsion or attraction, he declares that he meant nothing but effects. The law already stated will explain, or at least classify, reflection. When light is detained by any obstacle, it is in the vicinity of that obstacle, in greater quantity than elsewhere. Reflecting objects, therefore, virtually become centres of radiation. The light passes outward from these, because surrounding space is more vacuous of this form. Newton pointed out that light was reflected before actually impinging on bodies, and he accounted, as usual, for this, by saying that the repulsive power of bodies acted at a certain distance. But the fact that light, in falling on bodies, should not all impinge before reflection, is no more mysterious, than that all the water or air of a jet directed upon a body should not touch the body.

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Part of it is prevented from touching by what is nearer the body. I have remarked that vision is no necessary property of the opticable form, nor feeling of the tangible. Both vision and feeling, as well as our other sensations, result from forms of matter suited to their character. Darkness may not only be the absence of light, it may be its equal diffusion. A room may be full of air where there is no wind: and the opticable form may, if it surround us equally, and be not flowing from any particular point, produce no vision. But in this condition it may subserve the purposes of terrestrial magnetism, or of electrical phenomena, or of heat: for this fluid seems just as good for these purposes, as any other whose existence is less certain.

Gra. I admit that you have rendered your theory very probable, but is it not the same as that of Empedocles, who made fire or light, air, earth, and water the elements of all things?

Ment. No; for, whereas that philosopher made fire, air, water, and earth the elements of things, I merely regard these as what may be called the cardinal forms of matter. But the elements are perhaps seen in the rays of the spectrum. Sir H. Davy observes, that two or three simple substances may produce all that variety of bodies found in Nature. And Mosotti has more recently proposed the doctrine of two ultimate elements. If a certain ratio of all the elements of matter exists in a given portion of the visual form of matter, and if that which

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produces the sensations of red, yellow, and blue, be a just analysis of this form, we shall have the ultimate elements reduced to these three matters.

Syl. It is now my opinion, since your doctrine, Mentor, does not destroy the undulatory theory, that no arguments can be brought against that doctrine so strong and intelligible as what may be urged in its favour.

Ment. Gentlemen, you are far too complimentary; for, although I believe most solemnly in the truth of what I have stated, so little has been brought forward, that the complete establishment of this view was not to be looked for. Had we time to consider this plain fact of optics, in relation to Astronomy, Geology, Cosmogony, Chemistry, Physiology, and, in short, to the whole structure of Nature, you would be better able to judge of its truth and importance. We should then know somewhat of that which is really doing about us. We should then perceive the truth of Kepler's assertion, that the perfection of Astronomy must accompany the perfection of Physics. We should see that the dynamics of our solar system depend upon a physical evolution, which brings creation to our very doors, and our own times: and this not in any figurative sense, but in the intimate sense of rearing up globes from a germ possibly no bigger than a man's hand, to dimensions which yield a measurable angle, over hundreds of millions of miles. Nor can we doubt that, since there are before our.

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eyes processes going on for the augmentation of globes, there must also be processes for giving origin to these globes, in the form of asterolites, or cometic bodies, which may be adopted into the satellitary families of planets, and impelled by the mechanical laws of the system into harmony with the general motions. At any rate, there can be no shadow of doubt, that the whole problem of creation is being wrought out by material forms in our system, and throughout the universe, at this moment. Since the time that God said, "Let there be light," and thereby called all matter into existence, there have passed by no cosmical operations, lost to us of these days. The activity of astral generation is here present: our new optics proves this to a demonstration. We have come into the presence of a vital fact. It strips the old traditions from Nature, and tells us that creation was not accomplished long ago, but that it is *the* very work which is in hand. It tells us that we have not to go abroad for creation to the dim nebulæ beyond the milky-way, but to sit still at home, and attend to what is doing here. At present we know not why all this life and death, this composition and decomposition, are going on about us. We know not the cause of the growing up of continents and mountain chains; nor of those mighty alternations of sea and land, which are the progressive footmarks of world-evolution. We know not why this movement of planets about a luminating center

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But when we find that light is a form of ordinary matter, and that therefore the sun, to throw abroad this form continually, must be in a slow state of decomposition, like any other source of light, one of the grandest mysteries of this universe bursts open before us, and scatters a munificence of truth, which this generation will not have time to gather. If matter be that unity, whose character you will now apprehend, the very fact that we see a star is a proof that that atom of space is fated to a secular duration: and the day will come, when not one of all the stars, known to the race of our humanity, shall shine amid the heavens. The matter of which they are composed will form new stars and new constellations. The pleiades shall no longer pour their sweet influence, nor Sirius his kingly ray. Our planetary globes are growing up in long millions of ages, by continual though insidious additions to the mass of their material. Here is an element of evolution in our system, which overturns all that we had demonstrated stable and enduring. If we look at our system in the light of the proposition here sketched, each orbit is seen to be, not a fiatory disposition, but a result of the orb which selects it, combined with the forces acting upon that orb. Each planet, with its satellites, is looking forward to the time, when itself shall assume the character of a sun: it is accumulating stores of material from the body decomposing at the centre. And with these accumulations, higher and higher orbits become its

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progressive habitats, and slower and slower motions its modes of journeying, until it rests amid the illimitable laboratory of Nature, to run the same round of decomposition as the stars from which it sprung, and to develope a new race, to perpetuate the astral generations. If our plain optical doctrine be true, more than this becomes inevitable. The frame of Nature receives a unity which, in our speculations, it certainly never possessed before. The universe becomes one work, and *we* know what is doing. The great drama presented to our gaze is nothing less than the intimate act of creation; but it is also the act of destruction: and surely all this is but what we ought to have expected. The Eternal is unchanging, and the work of his hand goes forward for ever. We have been accustomed to look out from this little observatory, as it speeds round the heavens, upon the wide scene, as if it were only an eternal play of bare, cold motion; but our new fact in optics tells us that all the motions are but results of the grand physical evolutions and involutions, which constitute the essential business of the cosmos. I speak not of creation in a figurative sense, but in a sense as literal as that which speaks of the growth of an animal. Creation is the one great present fact. It is that which is doing: it is what all this bustle is about. The presentness of creation is the underlying explanation of all phenomena. Wind, and rain, and river, and earthquake, are but menials of the mighty work going

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forward; but now we may understand whence they derive their instructions. The continual inpouring of new matter into the structure of our globe overturns all permanency and all stability. The atmosphere becomes displaced; the waters of the ocean can never rest from the work of degradation, and the laying down of new deposits: nor can these deposits maintain their positions for the elevation and disruption of their materials by perpetual additions from the centre of the system. We make no demand upon central fires; for even when such a rude hypothesis is granted, we stand as much as before in need of external causes to give occasion, at any given time, to the bursting or disruption supposed consequent on central fire: but in the continual current of new matter directed upon our globe, we have a most intelligible general cause, to which all geognostic motions may readily be referred. But we cannot enter upon the method of the evolution of planetary structures; nor how stars are necessarily in clusters; nor how the planets of our system, by a simple law of mechanics, move in one belt; nor how these planets rotate, and therefore revolve, and that by presently operating forces; nor how the orbits are different for the various orbs revolving in them; yet all this, and much more, becomes intelligible in the light of the doctrine, that the material world is a unity; that all forms of matter are elementally reciprocal.

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TABLE OF SENSIBLE FORMS,*

SHOWING THE SOURCE OF THE TERM "MATTER."

MATTER,

An abstract term, or general name, individualised from the sensible objects perceived by our Six Senses of

SEEING, THERMIC FEELING, TACTILE FEELING, HEARING, TASTING, SMELLING,

And these take cognizance of the compounds of the three ultimate elements (?) of Sensible Forms,

RED LIGHT, YELLOW LIGHT, BLUE LIGHT,

Which give rise to the four cardinal forms and their variations,

ETHEREAL.	GASEOUS.	LIQUID.	SOLID.
Red, yellow, and blue light, and their compounds.	Oxygen, Hydrogen, Nitrogen, &c. &c. &c.	Water, Oils, Spirits, &c. &c. &c.	Earths, Metals, Wood, &c. &c. &c.

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* Referred to at page 6.

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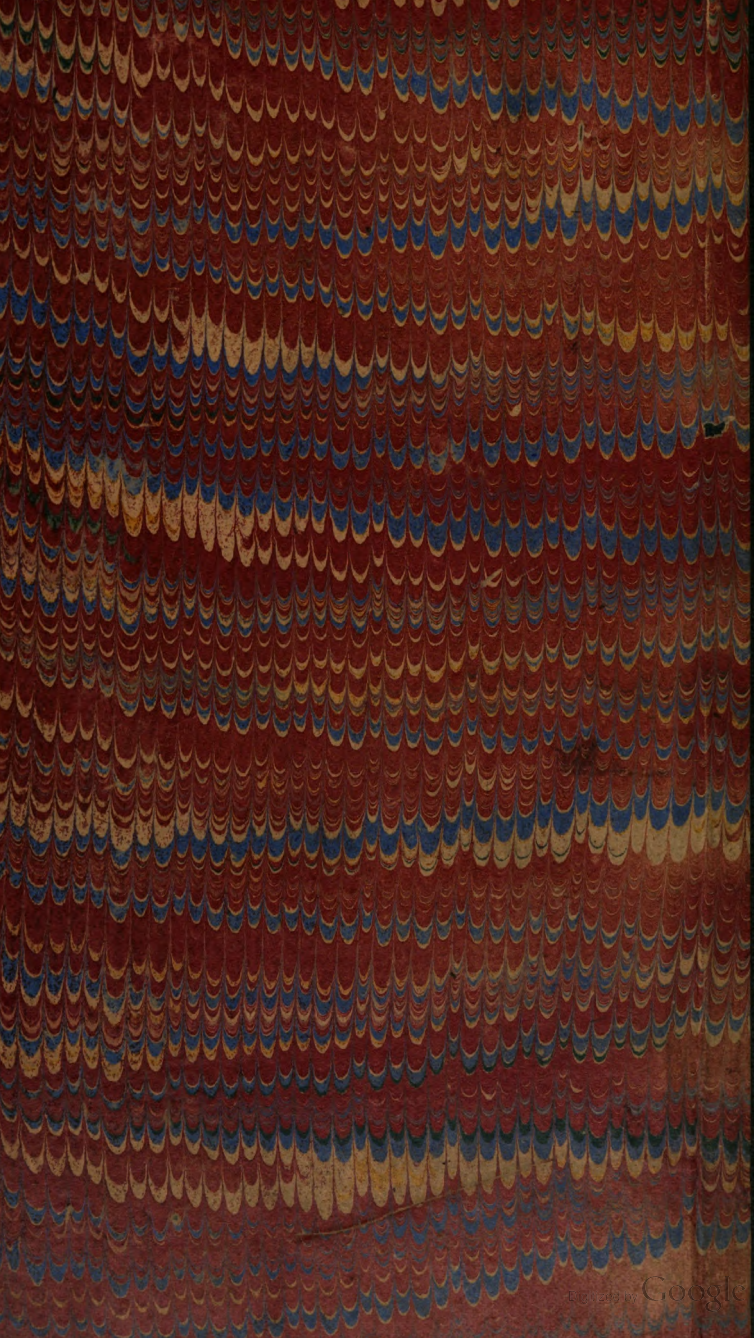
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